Module 6 - Steady State Circuits

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

Topic 1 - Components, Units, and Symbols

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- Common Passive Components
- Important Electrical Quantities
- Units and Symbols
- Circuits in Engineering

Common Passive Components

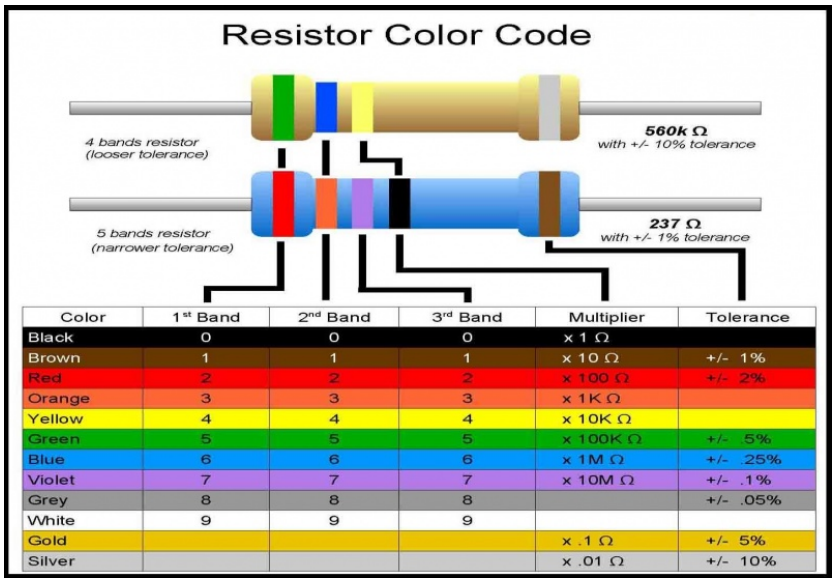
Passive components affect the behavior of a circuit in different ways but they do not generate power and can only absorb energy or transform it into heat. Active components on the other hand...

- Resistor
- Capacitor
- Inductor

Most circuits require an active power source for operation. A voltage source is used in most applications however current sources are also available and are needed for specialized electrical applications.

Common Passive Components

Components are identified by color codes and numbering systems. However it is always a good idea to measure for yourself because a marking can be incorrect or a component may be damaged.



Color	1st Band	2nd Band	3rd Band	Multiplier	Tolerance
Black	0	0	0	x 1 Ω	
Brown	1	1	1	x 10 Ω	+/- 1%
Red	2	2	2	x 100 Ω	+/- 2%
Orange	3	3	3	x 1K Ω	
Yellow	4	4	4	x 10K Ω	
Green	5	5	5	x 100K Ω	+/- .5%
Blue	6	6	6	x 1M Ω	+/- .25%
Violet	7	7	7	x 10M Ω	+/- .1%
Grey	8	8	8		+/- .05%
White	9	9	9		
Gold				x .1 Ω	+/- 5%
Silver				x .01 Ω	+/- 10%

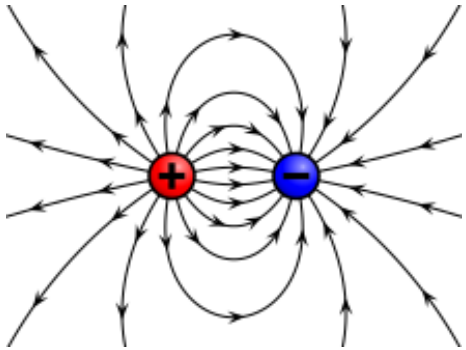
Codes of Ceramic Disc Capacitor

www.circuitspedia.com

Picofarad pF	Nanofarad nF	Microfarad µF	CODE	Picofarad pF	Nanofarad nF	Microfarad µF	CODE
10	0.01	0.00001	100	4700	4.7	0.0047	472
15	0.015	0.000015	150	5000	5.0	0.005	502
22	0.022	0.000022	220	5600	5.6	0.056	562
33	0.033	0.000033	330	6800	6.8	0.0068	682
47	0.047	0.000047	470	10000	10	0.01	103
100	0.1	0.0001	101	15000	15	0.015	153
120	0.12	0.00012	121	22000	22	0.022	223
130	0.13	0.00013	131	33000	33	0.033	333
150	0.15	0.00015	151	47000	47	0.047	473
180	0.18	0.00018	181	68000	68	0.068	683
220	0.22	0.00022	221	100000	100	0.1	104
330	0.33	0.00033	331	150000	150	0.15	154
470	0.47	0.00047	471	200000	200	0.2	254
560	0.56	0.00056	561	220000	220	0.22	224
680	0.68	0.00068	681	330000	330	0.33	334
750	0.75	0.00075	751	470000	470	0.47	474
820	0.82	0.00082	821	680000	680	0.68	684
1000	1.0	0.001	102	1000000	1000	1.0	105
1500	1.5	0.0015	152	1500000	1500	1.5	155
2000	2.0	0.002	202	2000000	2000	2.0	205
2200	2.2	0.0022	222	2200000	2200	2.2	225
3300	3.3	0.0033	332	3300000	3300	3.3	335

Important Electrical Quantities

- Charge - the physical property of matter that causes it to experience a force when placed in an electromagnetic field.



- Voltage - the difference in electric potential between two points ... can be caused by electric charge, by electric current through a magnetic field, by time-varying magnetic fields, or some combination of these three.
- Current - the rate of flow of electric charge past a point or region. An electric current is said to exist when there is a net flow of electric charge through a region.

Important Electrical Quantities

- Resistance - a measure of a components opposition to the flow of electric current. The inverse quantity is electrical conductance, and is the ease with which an electric current passes.
- Capacitance - the ratio of the change in electric charge of a system to the corresponding change in its electric potential (voltage).
- Inductance - the tendency of an electrical conductor to oppose a change in the electric current flowing through it. The flow of electric current creates a magnetic field around the conductor. The field strength depends on the magnitude of the current, and follows any changes in current.

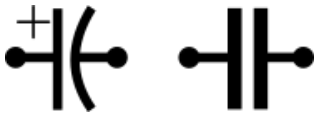
Units and Symbols

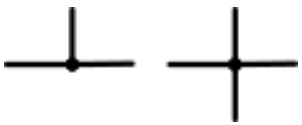
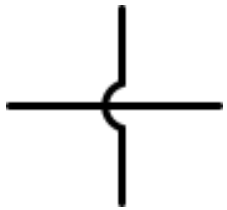
Quantity	Symbol	Unit	Abbr.
Charge	Q,q	Coulomb	C
Voltage	V,v	Volt	v
Current	I,i	Ampere	A
Resistance	R	Ohm	Ω
Capacitance	C	Farad	F
Inductance	L	Henry	H

Question: When should you use upper case or lower case letters for electrical quantities?

Units and Symbols

When working with a or building a circuit you need a diagram. Draw or find one before you begin. Here are some commonly used symbols.


Circuits in Engineering

Fluid Flow Analogy

Traditionally engineers have used an analogy relating the movement of electrons to the flow of water through a pipe (hydraulic analogy) known as *drain-pipe theory*.

This may provided a sense of intuition this comparison is not accurate do to the non-Newtonian nature of electricity and magnetism (more on this). It can be used to visualize some basic circuits principles, but it should not be used for analysis of complex electrical systems.

Circuits in Engineering

Circuits in Mechanical Engineering

How much does a mechanical engineer need to know about electricity and magnetism? This is good question, and obviously it varies based on your particular area of mechanical engineering.

Regardless, engineering is an integrated discipline and very few products or designs are isolated so to a single field.

Further the need for measurements in mechanical systems drives the need for a mechanical engineer to have a solid foundation in basic circuits theory.